

Remarks

The specification is amended herein to correct typographical errors. Claims 11 - 17 are newly added herein. No new matter is introduced by any of the amendments herein, and entry thereof is respectfully requested. Claims 1 - 17 are in the application. Reconsideration of the application as amended is requested, in view of the following Remarks.

Applicants' invention provides improved thermal performance in a PBGA, by employing a large heat spreader externally attached to the upper surface of the mold cap. Because according to the invention the heat spreader is externally affixed to the upper surface of the mold cap, the entire heat spreader is external to the mold cap, and is not embedded in the mold cap. In some embodiments (as illustrated for example in Applicants' Figs. 3, 4, 6) the periphery of the heat spreader extends down to the substrate and substantially covers the entire surface of the mold cap and the margins of the surface of the substrate adjacent the lower edges of the mold cap, but the heat spreader is free of attachment to the surface of the substrate.

The specific points raised by the Examiner will now be addressed, beginning with the rejections in the Office action mailed May 12, 2003 (the "Office Action"), and followed by the Examiner's comments in the Advisory Action mailed November 13, 2003.

Office Action: Rejections under 35 U.S.C. § 102, 103(a)

Claims 1 - 10 were rejected under 35 U.S.C. § 102(b) as being anticipated by, or in the alternative under 35 U.S.C. § 103(a) for obviousness over, Rostoker *et al.* U.S. 5,773,886 ("Rostoker"). These rejections are traversed.

The Examiner asserted:

Rostoker discloses in figure 4 a semiconductor device package comprising a semiconductor device (420) formed on a substrate (410), a mold cap (440), and a heat spreader (430) being entirely external to the mold cap.

Applicants, respectfully, disagree with the Examiner's reading of Rostoker. The feature (440) in Rostoker is not a mold cap; and Rostoker does not describe or suggest a heat spreader affixed to an upper surface of a mold cap, as in Applicants' claimed invention. Rostoker FIG. 4 shows

“assembly of a stacked heat sink arrangement to a glob-type package” (Col. 5, lines 39 - 41), and Rostoker describes the encapsulant feature (440) as follows (Col. 8, lines 26 - 33, referring to FIG. 4):

A dollop 440 of epoxy or other encapsulant is used to cover the die and its electrical connections. A stacked heat sink assembly 430 (see, e.g., 110b, FIG. 1b) is embedded in the epoxy dollop 440 such that the button-like projection on its bottom surface is in close proximity with the semiconductor die 420, thereby providing means for dissipating heat generated in the operation of the die 420.

The distinction is significant between a mold cap, as in Applicants’ invention, and the encapsulant of Rostoker.

As is known in the art, a “mold cap” is formed by molding (*See, e.g., Applicants’ Fig. 1, and page 3, lines 27 - 29*). Typically, the mold cavity is positioned over the wire-bonded die-and-substrate assembly, and the molding compound is injected to enclose the die and wire bonds and fill the cavity, and then is cured to form the mold cap. The shape of the completed mold cap, accordingly, is established by the shape of the mold cavity and, typically, the mold cap has the shape of a truncated rectangular (*e.g., square*) pyramid with chamfered slant edges (*See, e.g., Applicants’ page 3, line 36 - page 4, line 1*) and a flat upper surface having dimensions somewhat smaller than the base. (Where a heat spreader is embedded in the mold cap (*See, e.g., Applicants’ Fig. 2, and description relating thereto*), the heat spreader is typically either affixed to the substrate or dropped into the mold cavity; either way, the conventional embedded heat spreader is not affixed to an upper surface of the mold cap.)

The feature 440 in Rostoker is formed by displacement as the heat sink assembly is pressed into and embedded in the dollop of epoxy 400. That is, in Rostoker there is no “mold cap ... having an upper surface” to which a heat spreader is “affixed”, as in Applicants’ invention as claimed (*see, e.g., Applicants’ claim 1*). Accordingly, the rejection for anticipation by Rostoker should be withdrawn.

Moreover, there is no suggestion in Rostoker of a “mold cap ... having an upper surface” to which a heat spreader is “affixed”, as in Applicants’ invention as claimed; nor is there any teaching in Rostoker that would suggest how to make a package having a mold cap having a heat

spreader affixed to its upper surface, as in Applicants' claim 1. Claims 2 - 10 depend from claim 1. Accordingly, the Rejections for obviousness over Rostoker should be withdrawn.

Claims 1 - 10 were rejected under 35 U.S.C. § 102(e) as being anticipated by, or in the alternative under 35 U.S.C. § 103(a) for obviousness over, Johnson *et al.* U.S. 6,288,900 ("Johnson"). These rejections are traversed.

The Examiner asserted:

Johnson discloses in figure 10 a semiconductor device package comprising a semiconductor device (14) formed on a substrate (12), a mold cap (24), and a heat spreader (22) being entirely external to the mold cap.

Here, too, Applicants, respectfully, disagree with the Examiner's reading of Johnson. The feature (24) in Johnson is not a mold cap; it is an encapsulant. Johnson describes the heat spreader as being attached to the chip and substrate by means of the encapsulant. Referring to FIG. 1, Johnson states:

A heat spreader or cap 18 is mounted on top of the chip 14 in order to dissipate heat and counter-balance the forces exerted by the thermal mismatch between the chip 14 and the substrate 12. The cap 18 is attached to the chip and substrate by means of encapsulant 19, which is usually an epoxy.

(Johnson, Col. 3, lines 31 - 37.) And, referring to FIG. 8:

In this embodiment, the heat spreading layer 22 comprises a plurality of holes or grooves 32. The holes or grooves 32 are filled with encapsulant 24 during assembly, thereby aiding adhesion.

(Johnson, Col. 4, lines 25 - 28.)

In Johnson, as in Rostoker, the encapsulant feature 19, 24 is formed by displacement as the heat sink assembly is pressed into and embedded in the epoxy; and it serves as an adhesive or means of attachment of the heat sink to the chip and substrate. The effect of displacement is shown in the Figs. in Johnson by the rounded profile of the encapsulant at the edges, illustrating a bulge outward resulting by the pressing of the heat spreader onto the mass of epoxy.

In other words, in Johnson as in Rostoker there is no “mold cap ... having an upper surface” to which a heat spreader is “affixed”, as in Applicants’ invention as claimed (*see, e.g.*, Applicants’ claim 1). Accordingly, the rejection for anticipation by Johnson should be withdrawn.

Moreover, there is no suggestion in Johnson of a “mold cap ... having an upper surface” to which a heat spreader is “affixed”, as in Applicants’ invention as claimed; nor is there any teaching in Johnson that would suggest how to make a package having a mold cap having a heat spreader affixed to its upper surface, as in Applicants’ claim 1. Claims 2 - 10 depend from claim 1. Accordingly, the Rejections for obviousness over Johnson should be withdrawn.

Advisory Action

In an Advisory Action mailed November 13, 2003, the Examiner asserted that Applicants’ Amendment filed September 12, 2003 does not place the application in condition for allowance “because: element 440 in Rostoker et al and element 24 of Johnson et al are mold cap.” This merely restates the Examiner’s earlier position, without consideration of the detailed Remarks in Applicants’ September 12, 2003 Amendment (reproduced above).

The element 440 in Rostoker is manifestly not formed in a mold. Rostoker expressly states (referring to Fig. 4) that the “stacked heat sink assembly 430 ... is **embedded in the epoxy dollop 440** ...” And the element 19, 24 is expressly stated in Johnson to be an encapsulant by which the heat spreader or cap is attached to the chip and substrate. In both Rostoker and Johnson, the “epoxy dollop” or encapsulant is shown in the figures as having been displaced laterally as the heat spreader is pressed onto it, as evidenced by the bulges at the sides. That is, neither the epoxy dollop 440 of Rostoker nor the encapsulant 19, 24 of Johnson has an upper surface, to which the heat spreader is attached.

The Examiner remarks further:

If they are not formed in a mold, epoxy will not be concentrated at the chip area but will spread to other area as well. The shape of the cap will not be unique in order to attach the heat spreader to the cap. It is well known in semiconductor art that the cap of the semiconductor chip is formed in the mold. The specification failed to disclose the criticality of “mold” as now argued.

These remarks are not well understood, and clarification of the Examiner’s point is respectfully requested.

It is indeed well known that a mold cap is formed in a mold. Applicants' specification acknowledges this, with reference to Fig. 1:

Semiconductor device 14 is electrically connected to substrate 12 via wire bonds 18 such as gold wires and molded with molding compound to form a mold cap 20 to protect the device and the wire bonds.

(Applicants' paragraph [0018].) The mold cap, thus formed, has an upper surface and, according to Applicants' invention, it is the upper surface of the mold cap to which the heat spreader is attached. A dollop of epoxy (Rostoker) or a mass of encapsulant (Johnson) has no upper surface to which a heat spreader is attached. In the completed package, Rostoker's 440 and Johnson's 19, 24 are limited by the interface formed by the surface of the heat spreader as it is pressed onto them; but that interface is not a surface of a mold cap to which the heat spreader is attached.

New claims 14 - 17 recite an adhesive between a portion of the mold cap and the heat spreader, by which the heat spreader is affixed to the mold cap. These recitations are supported, for example, in Applicants' specification at paragraphs [0005], [0025], [0033], and as shown in the Figs. New claims 11 and 12 are directed to embodiments having substantially the entire surface of the mold cap (*i.e.*, top and sides) covered by the heat spreader, as shown for example in Applicants' Figs. 3, 4 and 6, and described, for example, at paragraph [0025] with reference thereto.

In view of the foregoing, it is believed that all the claims in the application are in condition for allowance, and action to that effect is requested.

This response accompanies a Request for Continued Examination, and a fee therefor.

This response is being filed within two months following the second month after the filing of a Notice of Appeal in this application and, accordingly, it is accompanied by a petition for two months' extension of time and a fee or fee authorization therefor. In the event the Examiner may determine that an additional fee may be required in connection with the filing of this paper, the


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Commissioner is hereby authorized to charge any such fee[s] to Deposit Account 50-0869 (Order No. CPAC 1013-2).

If the Examiner determines that a conference would facilitate prosecution of this application, the Examiner is invited to telephone Applicants' representative, undersigned, at the telephone number set out below.

Respectfully submitted,

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